Apollo®
Model SL50 GPS
Model SL60 GPS / VHF COMM
Installation Manual

MORROW
VISIONARY THINKING TODAY

February 2002 560-0957-02

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HISTORY OF REVISIONS

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--	2/24/97	Initial release.
-01	3/14/97	Change coax recommendation from RG-58 to RG-142B
-01a	9/23/99	Added new connector pins and crimping tools
-02	2/8/02	Added user set Comm functions. SW Version 1.1 and helicopter environmental qualification

IMPORTANT NOTE

"The conditions and tests required for TSO approval of this article are minimum performance standards. It is the responsibility of those desiring to install this article on or within a specific type or class of aircraft to determine that the aircraft operating conditions are within TSO standards. The article may be installed only if further evaluation by the applicant documents an acceptable installation and is approved by the Administrator."

Source: FAA TSO-C37d, TSO-C38d, TSO-C128, and TSO-C129

ORDERING INFORMATION

To receive additional copies of this publication, order part # 560-0957-01b, *Apollo SL50/SL60 GPS / VHF COMM Installation Manual*.

REFERENCE PUBLICATIONS

Following are other publications referenced in this guide. *Apollo SL50/SL60 GPS/VHF COMM User's Guide, 560-0955-xx.*

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NOTES

SECTION 1 - INTRODUCTION

ABOUT THIS MANUAL

This manual describes the installation of the Apollo SL50 GPS and SL60 GPS/Comm units. It is intended for use by persons certified by the Federal Aviation Administration (FAA) to install aircraft navigation devices. It includes installation and checkout procedures for the SL50 and SL60 units to standards described in FAA advisory circulars AC 20-138 (for GPS) and AC 20-67B (for comm).

The SL50 and SL60 units are equivalent except for the SL50 does not include the VHF Comm. Throughout this manual, references to the SL50/60 are for both the SL50 and SL60.

Section 1 — Provides an **introduction** to the Apollo SL60 unit. TSO certification information is also included in this section.

Section 2 — Includes **installation** and checkout procedures.

Section 3 — Includes complete **specifications**.

Section 4 — Includes **limitations** for the equipment and installation.

Appendix A — Includes **troubleshooting** information.

Appendix B — Includes **periodic maintenance** requirements.

Appendix C — Includes the **environmental qualification form**.

Appendix D — Includes information on **accessories**.

Appendix E — Includes **serial data specifications**.

APOLLO SL50 / SL60 DESCRIPTION

The Apollo SL50 GPS is a TSO-C129 GPS supplemental navigation receiver for IFR enroute and terminal operation. It includes a built-in data base that can be updated through a serial port.

The Apollo SL60 GPS/Comm includes the same GPS capabilities as the SL50 and includes a 760 channel VHF Comm transceiver.

The Apollo SL50 and SL60 are two members of the Apollo slimline series which include the SL40 Comm, the SL50 GPS, and the SL60 GPS/Comm.

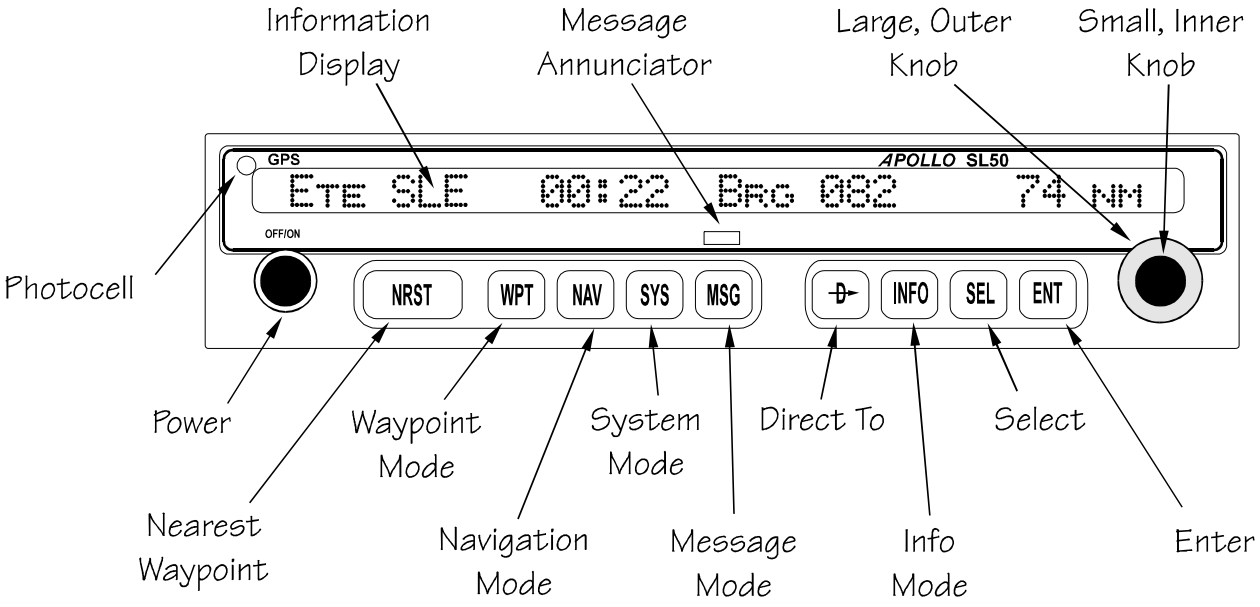


Figure 1 SL50 Front Panel

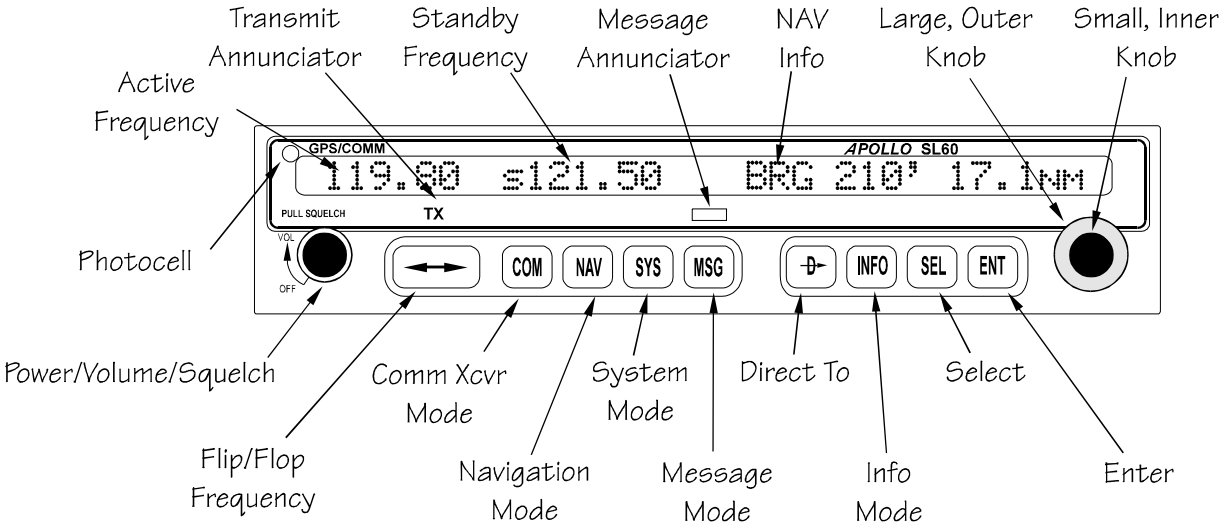


Figure 2 SL60 Front Panel

FEATURES

The GPS navigation features for the SL50 GPS and SL60 GPS/Comm include:

- 32 character high-intensity alphanumeric LED display
- Automatic display intensity
- Back-lit buttons
- Simple "Direct-To" navigation
- Built-in data base updatable through a serial port
- Nearest waypoint search (includes airports, VORs, NDBs, intersections, and user waypoints)
- Remote waypoint search
- Navigation displays -
  - Lat/Lon to 0.01 minute
  - Bearing and distance to waypoint
  - Ground speed and track angle
  - Desired track and distance between waypoints
  - Cross track error with numeric and graphic CDI
  - Display of the "TO" waypoint ident
  - ETE and ETA to the "TO" and destination waypoints
- Automatic waypoint sequencing
- Built-in simulator for trip planning and training
- User definable navigation pages with auto sequencing
- 10 flight plans of 20 legs each
- 200 user waypoints created by lat/lon or by radial/distance from a reference waypoint
- User selectable units -
  - nm or km for distance displays
  - knots or kph for speed displays
- Real time clock (time and date) in UTC
- Countdown timer
- Flight timer
- Automatic or manual magnetic variation
- Parallel track offset
- Alerts for -
  - Loss of navigation
  - Arrival at waypoint
  - Special use airspace
- Full range input supply voltage

The VHF Comm features of the SL60 GPS/Comm include:

- 760 channels
- Frequency range of 118.000 to 136.975MHz
- Active and standby frequency display
- Transmit status indicator
- Stuck mic time-out

- Frequency monitor function
- Weather channels (only in Americas database)
- Built-in intercom function
- Frequency memory and recall functions
  - from navigation data base
  - eight last used
  - eight user stored
- Two microphone inputs
- 12 watt audio amplifier
- Remote flip/flop input

SYSTEM CONFIGURATIONS

The SL50 and SL60 can be installed in several configurations based upon individual requirements. This includes with or without the comm transceiver, and VFR or IFR GPS navigation. This section defines the minimum requirements.

VFR GPS NAVIGATION INSTALLATION

When installed for VFR operation, the SL50/60 requires only the following minimal connections.

- an A-33 GPS antenna
- power input

The SL50/60 can also be connected to other external devices such as:

- an external non-numeric indicator, such as a CDI or HSI
- external lamp annunciators including “MSG” and “PTK”
- an “OBS/HLD” external annunciator (with switch)
- an autopilot
- a moving map display connected to an RS-232 serial output

When the SL50/60 is installed for VFR, a placard stating “GPS Limited to VFR Use Only” or an FAA approved equivalent statement must be placed next to the primary indicator

IFR GPS NAVIGATION INSTALLATION

When installed for IFR operation, the SL50/60 requires connections to several external indicators. The minimum connections for IFR operation is as follows.

- an A-33 GPS antenna
- power input
- an external non-numeric indicator, such as a CDI or HSI
- external lamp annunciators including “MSG” and “PTK”

The following additional connections are recommended, but not required.

- an “OBS/HLD” external annunciator (with switch)

The SL50/60 can also be connected to other external devices such as:

- an autopilot
- a moving map display connected to an RS-232 serial output

COMM TRANSCEIVER - SL60

For standalone installations, the comm requires connections to:

- a standard comm antenna
- a microphone (or microphones)
- a speaker or headphone
- power input

These items may be installed dedicated to the SL60 comm, or by connection to an audio panel.

DATABASE UPDATES

The SL50/60 includes a built-in Flybrary database stored in flash memory. The database can be updated through the RS-232 connection on the rear of the unit using a PC. The Waypoint Manager program (available from II Morrow) is required.

The database can be updated by removing the SL50/60 from the aircraft and connecting it to a PC and providing a 10 to 40 volt DC power source. A cable assembly (see page 45) is available from II Morrow for this purpose.

To update the database. connect the SL50/60 to power and the PC. On the SL50/60, press SYS, rotate the LARGE knob to select the "DATABASE UPDATE:" page, then press ENT. Follow the Waypoint Manager instructions for downloading the new database. The SL50/60 will display the programming status, when it is complete, and if an error occurs.

Contact the II Morrow factory for information on databases available for the SL50/60.

REGULATORY COMPLIANCE

The Apollo SL60 is designed and tested to meet the following TSOs:
FAA TSO-C37d for transmit
FAA TSO-C38d for receive
FAA TSO-C128 for unintentional transmission (stuck mic)
FAA TSO-C129 for GPS navigation

The Apollo SL50 is designed and tested to meet the following TSOs:
FAA TSO-C129 for GPS navigation

The Apollo SL60 comm complies with the FCC requirements specified in:
CFR 47, Part 87, Aviation Services, Subpart D, Technical Requirements

The Apollo SL50 and SL60 comply with the FCC requirements specified in:
CFR 47, Part 15, Radio Frequency Devices, Subpart B, Unintentional Radiators

The Apollo SL50/60 software is designed and tested to RTCA/DO-178B, level C.

Note: Un-authorized changes or modifications to the SL50 or SL60 may void the compliance to required regulatory agencies and authorization for continued equipment usage.

UNPACKING THE EQUIPMENT

Carefully unpack the equipment. Visually inspect the package contents for any evidence of shipping damage. Retain all shipping containers and packaging material in case reshipment is necessary.

PACKAGE CONTENTS

As shipped from the II Morrow factory, the Apollo SL50/60 package includes most items necessary for installation other than supplies normally available at the installation shop, such as wire and cable ties, and required input and output equipment. The standard items included in the package are listed in Table 1.

Table 1 Package Contents

Part #	Description	Qty	
		SL50	SL60
Units			
430-6040-4xx	SL50 GPS	1	
430-6040-6xx	SL60 GPS / Comm		1
Install kits	Part number: 424-2006-	-4xx	-6xx
162-0100 or 162-1575	15 pin dsub connector shell		1
162-0103 or 162-1577	37 pin dsub connector shell	1	1
162-1008	Right angle coax plug	1	2
162-1060	TNC coax connector	1	1
202-0001	Cable tie	2	4
204-0037	Edge grommet	6”	6”
204-2100	Shoulder bushing	2	4
221-0400	4-40 x 1/4 SS pan head Phillips machine screw with lock washer	8	8
224-0404	4-40 x 1/4 SS flat head Phillips machine screw	2	4
245-0022 or 245-0027	Crimp contact for dsub, 20 to 24 awg wire	37	52
310-5181-xx	Mounting frame	1	1
310-5187-xx	Connector mounting plate	1	1
998-0048	3/32 hex driver	1	1
Manual kits	Part number: 564-0064-	-4xx	-6xx
560-0955-xx	SL50 / SL60 User’s Manual	1	1
560-0957-xx	SL50 / SL60 Installation Manual	1	1
560-9002	Binder, 5½ x 8½ x ¾, 3 ring	1	1
561-0235-xx	SL50 / SL60 Quick Reference Guide	1	1
Accessories			
560-0949	A-33 Installation Guide	1	1
590-1104	A-33 GPS Antenna	1	1

Note: Package contents may vary depending on how the unit is ordered.

OTHER REQUIRED MATERIALS

The SL50/60 is intended for use with standard aviation accessories. External devices required for various installations are listed in the System Configurations section on page 4. Depending upon the installation, this will include items such as:

- annunciators
- a CDI or HSI
- a comm antenna
- a microphone(s)
- a speaker or headphone

SPECIAL TOOLS REQUIRED

Crimp Tool

A crimp tool meeting MIL specification M22520/1-01 and a positioner/locater are required to ensure consistent, reliable crimp contact connections for the rear 15 pin connector. These tools are available from:

For pin p/n 162-0100

Astro Tool Corp.	Phone (503) 642-9853
21615 SW TV Highway	Fax (503) 591-7766
Beaverton, OR 97006	
Crimp tool:	Astro Tool part #615708
Positioner:	Astro Tool part #616356

For pin p/n 162-1575

ITT Cannon	Phone (714) 261-5300
1851 E. Deere Ave.	Fax (714) 575-8324
Santa Ana, CA 92705-6500	
Insertion tool:	ITT part # 274-7006-000 (Desc. CIET-20HD)
Regular duty Crimp tool:	ITT part #995-0001-585 (Desc. M22520/1-01)
Regular duty Locator tool:	ITT part #995-0001-244 (Desc. TH25)
Heavy duty Crimp tool:	ITT part #995-0001-584 (Desc. M22520/2-01)
Heavy duty Locator tool:	ITT part #995-0001-604 (Desc. M22520/2-08)

LICENSE REQUIREMENTS

An aircraft radio station license is required for operation of the SL60 comm transmitter once installed in the aircraft. An application must be submitted on FCC Form 404, which may be obtained from the FCC in Washington, DC, or any of its field offices. Procedures for applications are in CFR 47, Part 87, Aviation Services, Subpart B, Applications and Licenses.

NOTES

SECTION 2 - INSTALLATION

This section describes the installation of the SL50 and SL60 including mounting, wiring, and connections. A post installation check-out procedure is included at the end of this section.

PRE-INSTALLATION INFORMATION

Always follow good avionics installation practices per FAA Advisory Circulars (AC) 43.13-1A, 43.13-2A, AC 20-138, and AC 20-67B, or later FAA approved revisions of these documents.

Follow the installation procedure in this section as it is presented for a successful installation. Read the entire section before beginning the procedure. Perform the post installation check-out before closing the work area in case problems occur.

INSTALLATION OVERVIEW

A successful installation should start with careful planning including determination of mounting location for the SL50/60, antenna mounting, connections to microphones, speakers, and headphones, cable routing, and other required modifications. Once the mounting location has been determined, prepare the mounting frame for installation. It may be easier to complete the wiring harness and attach the connectors to the mounting frame before installing the mounting frame.

INSTALLATION CONSIDERATIONS

MOUNTING CONSIDERATIONS

The SL50/60 is designed to mount in the avionics stack in the aircraft instrument panel within easy view and reach of the pilot. The standard package includes a mounting frame for ease of mounting, connections, and service of the unit. Allow an additional one inch clearance to the rear of the mounting frame for connectors and cables.

For typical installations, the SL50/60 does not require external cooling. When mounting the unit, leave a clearance of 1/8 to 1/4 inch between avionics to allow for air circulation.

MINIMUM SYSTEM CONFIGURATION

The minimum system configuration and external connections requirements are described in the System Configurations section on page 4.

HELICOPTER REQUIREMENTS

The SL60 is qualified for helicopter installation with certain mount tube and SL60 configurations (see Section 4 - Limitations).

EQUIPMENT MOUNTING

Once the cable assemblies have been made, attach the 15 and 37 pin d-sub and coaxial cable connectors to the rear connector mounting plate and the mounting frame as illustrated in Figure 4 and

Figure 5. Route the wiring bundle as appropriate. The rear connector plate should be attached to the mounting frame before installing the frame in the instrument panel. The rear connector plate can be used to tie down the cable assemblies. Use the supplied edge guard to protect the cable from sharp edges. Connect the shield grounds directly to the connector mounting plate.

Once the cable assemblies, the connector mounting plate, and the mounting frame are assembled, install the mounting frame assembly in the instrument panel. Be sure to use low profile head screws so the unit will slide in and out freely. Attach the front of the mounting frame to the instrument panel. Use support brackets to attach the rear of the frame to the aircraft.

MOUNTING TUBE INSTALLATION

Care must be taken when installing the mounting tube to ensure you can properly insert and secure the unit. There must be a minimum vertical spacing of 0.040 inches between units to prevent interference with the cam locking mechanisms. Mounting tubes with clearance dimples help maintain the proper clearance. The mounting tube must be installed with the clearance dimples pointing up.

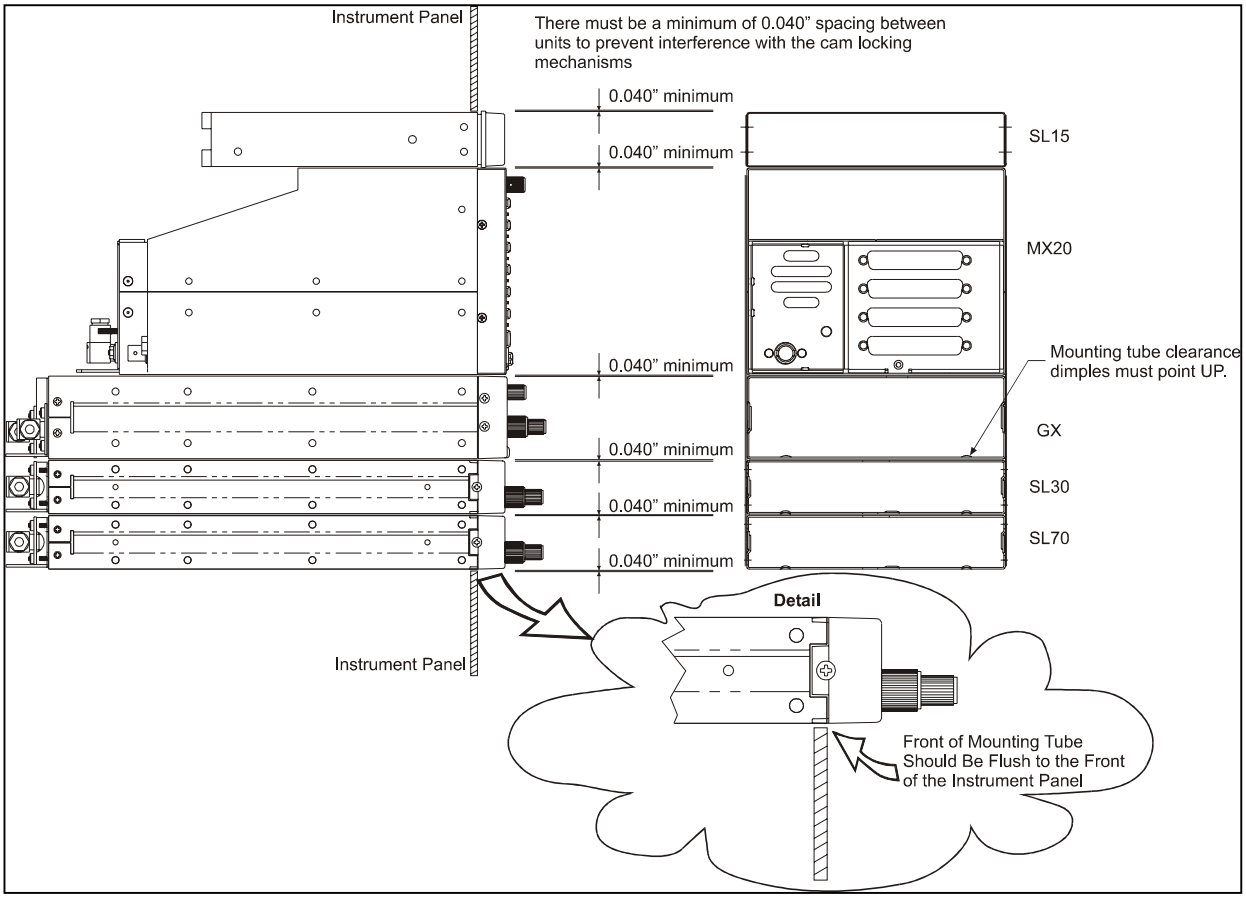


Figure 3 - Full Stack Mounting Tube Spacing

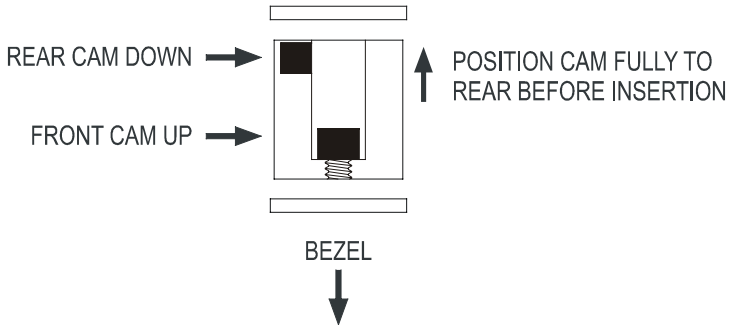
The mounting tube should be flush to the instrument panel and allow sufficient clearance for the back of the bezel of the unit to mount flush to the mounting tube. Sufficient clearance must exist in the instrument panel opening to allow ease of insertion and removal of the unit. **If the back**

of the unit bezel does not mount flush to the mounting tube, the connector may not engage fully.

Secure the mounting tube to the instrument panel structure. Mounting screw heads must not protrude into the mounting tube. Be sure to use the appropriate screws so the unit will slide in and out freely. The screws attaching the mounting tube to the instrument panel structure must not interfere with the insertion of the unit. Failure to prevent interference will result in damage to the unit or prevent its insertion. Take care that the mounting tube is not distorted when it is attached to the instrument panel and structural supports. Shims may be necessary to properly install the mounting tube. If the mounting tube is distorted out of square, the unit may either bind when being inserted or the cam lock may not engage.

UNIT INSERTION

Position the cam lock as shown below. The front lobe of the cam should be vertical. The cam lock mechanism should be fully unscrewed (turned counter-clockwise). Slide the unit into the frame. Turn (clockwise) and carefully **hand-tighten** (4 in-lb max.) the cam lock mechanism using **only** the 3/32" hex driver provided in the installation package. Using a larger tool than the one provided makes it easy to exceed the allowable torque on the cam lock resulting in damage to the unit. The unit will be pulled into the frame securing the unit and the connectors will fully engage. **Do NOT overtighten.** The back of the bezel must only be flush to the mounting tube. If the cam lock is hard to turn or the unit does not seat fully, the unit is probably binding and the mounting tube should be checked.



UNIT REMOVAL

To remove the unit from the mounting frame, turn the screw counter-clockwise with the hex driver to unscrew the cam lock mechanism. The unit will begin to pull away from the mounting tube. Turn the screw until slight resistance is felt and then pull the unit from the frame. **Do not exert excessive turning force at the end of the cam lock travel or the unit may be damaged.** With the cam lock fully disengaged, pull the unit straight out holding onto the sides of the bezel. It is not recommended that you pull the unit out by the rotary knobs. No special extraction tools are required, if the mounting tube is properly installed.

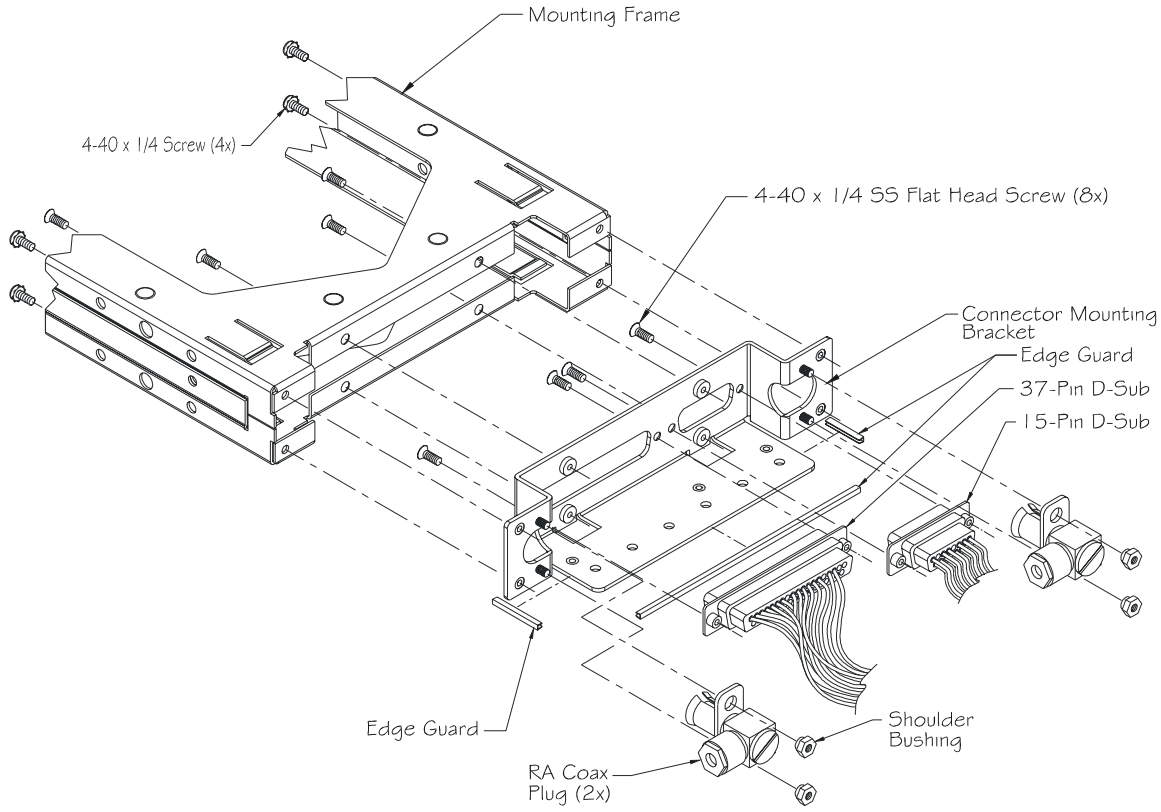


Figure 4 - Mounting Frame Assembly

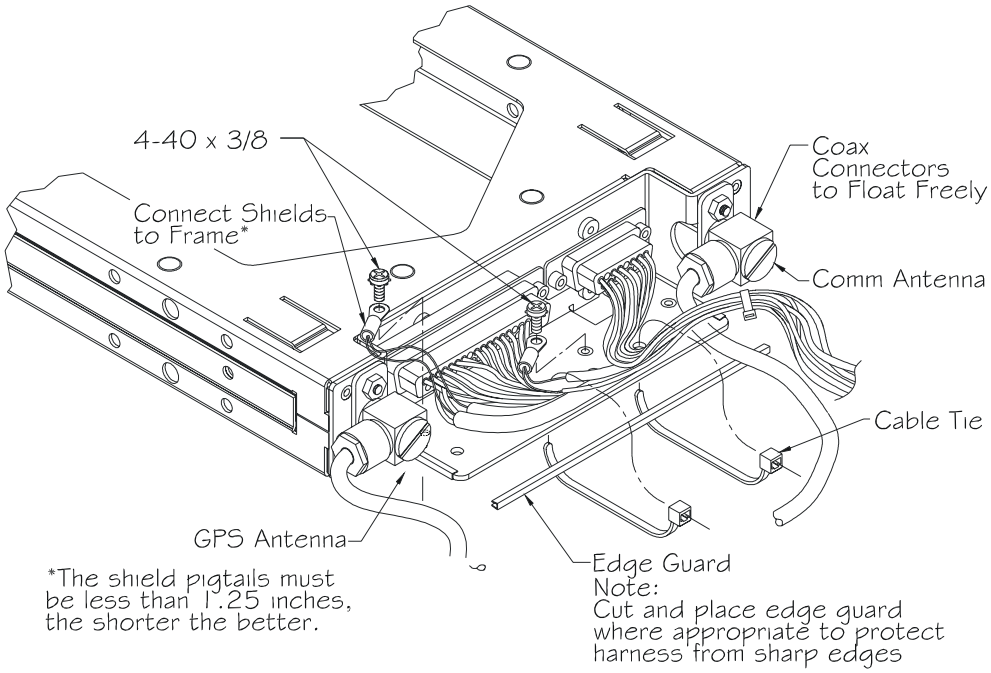

4-40 x 3/8
Connect Shields to Frame*
Coax Connectors to Float Freely
Comm Antenna
Cable Tie
GPS Antenna
*The shield pigtails must be less than 1.25 inches, the shorter the better.
Edge Guard
Note:
Cut and place edge guard where appropriate to protect harness from sharp edges

Figure 5 Cable Routing

ELECTRICAL CONNECTIONS

The SL60 installation kit includes 15 and 37 pin dsub shells and crimp contacts, the SL50 has only the 37 pin shell. The crimp contacts are specified for 20 to 24 awg wire. Make the crimp connections with a crimp tool as specified in the Special Tools Required section on page 7. All wires should be 20 to 24 AWG unless otherwise specified. Wiring diagrams are included in Figure 8 through Figure 11.

POWER

The SL60 requires two power connections, one for the GPS navigation side of the unit, the other for the comm. Make the power connections to the unit using 20 awg wire.

The GPS navigation power input is internally fused at 3 amps. A separate 2 amp (maximum) circuit breaker or fuse should be installed for downline overload or short circuit protection.

The comm power input (SL60 only) is internally fused at 7 amps. A separate 5 amp (maximum) circuit breaker or fuse should be installed for downline overload or short circuit protection.

> ***Note:*** *Circuits should be protected in accordance with guidelines in AC 43.13-1A, chapter 11, section 2, paragraph 429.*

> ***Warning***
> *When connecting power to the GX unit, reversing the polarity of the connection will blow the internal fuse. The internal fuse is soldered onto the circuit board and requires repair at the factory.*

AVIONICS OUTPUTS

The SL50/60 includes full avionics outputs for CDI/HSI indicators, autopilot, and annunciators. These outputs are to be connected as appropriate for the particular installation. The CDI/HSI outputs may be connected to a dedicated CDI or HSI or to a shared indicator using an appropriate switching relay. The avionics outputs available are listed in the Avionics Outputs specification on page 31. Connect the annunciator outputs to lamp indicators as described in the specifications. The minimum connections required for different installations are listed in the System Configurations on page 4.

If a switching relay is used to make connections to a shared CDI/HSI, it should be a minimum of an eight pole relay box with an appropriate selector switch with annunciation. Since the SL50/60 is not approved for approach operation, the ILS enable signal from a connected ILS receiver can be connected to automatically switch the indicators back to the nav receiver when an ILS frequency is selected.

SERIAL INTERFACE

The SL50/60 includes an RS-232 serial port for making optional connections. The serial port can be used for connecting to such devices as the Apollo 360 map, the Apollo SL40 comm, an Argus moving map display, or a Stormscope.

When making connections to the SL50/60, use a three conductor shielded cable. Make RxD, TxD, and signal ground connections to the 37 pin connector. Connect the shield(s) to the rear of the mounting frame on the connector plate. The shield leads must be < 1.25 inches. See Figure 5.

Complete serial interface specifications are included in Appendix E.

SIMULATOR SELECT INPUT

The simulator select pin on the 37 pin connector must be connected to ground on pin 25. If left unconnected, the unit will operate in the built-in simulator mode.

SPEAKER AND HEADPHONE OUTPUTS (SL60 ONLY)

Connect the speaker and headphones to the output pins on the rear connector.

MICROPHONE INPUTS (SL60 ONLY)

Microphone input connections should be made using a twisted pair shielded cable. Attach the signal ground to the mic ground pin on the rear connector and connect the shield to the rear connector plate.

TRANSMIT KEY INPUT (SL60 ONLY)

The TxKey input on the rear connector must be pulled low to ground to enable the transmitter. This input should be connected to a microphone or yoke mounted momentary push button switch.

INTERCOM SELECTOR SWITCH (SL60 ONLY)

The SL60 includes a voice activated intercom function that can be enabled by an external control switch. This is an optional connection.

When making connection for the intercom selection, connect the intercom selection input to a remote mounted normally open switch. A momentary toggle or alternate action switch can be used. Connect the other terminal of the switch to ground. The intercom function is enabled when the input is pulled low to ground. The monitor function is inhibited when the intercom function is selected.

REMOTE FLIP/FLOP INPUT (SL60 ONLY)

The SL60 includes a remote flip/flop input. This is an optional input can be connected to a remote mounted (such as on the yoke) momentary push button switch which pulls the input low to ground.

ANTENNA INSTALLATION AND CONNECTIONS

COMM ANTENNA (SL60 ONLY)

The SL60 requires a standard 50Ω vertically polarized antenna. Follow the antenna manufacturer's installation instructions for mounting the antenna.

The antenna should be mounted on a metal surface or a ground plane with a minimum area of 18 x 18 inches. The antenna should be mounted a minimum of two feet away from GPS antennas.

The comm antenna should also be mounted as far apart as practical from the ELT antenna, preferably one on top and the other on the bottom of the aircraft fuselage. Some ELTs have exhibited re-radiation problems generating harmonics that may interfere with GPS signals. This can happen when the comm (SL40 or any other comm) is transmitting on certain frequencies such as 121.15 or 121.175MHz, which may cause the ELT output circuit to oscillate from the signal coming in on the ELT antenna coax.

The antenna coax cable should be made of RG-142B or a comparable quality 50Ω coax. Assembly instructions for the rear coax connector are included in Figure 6.

GPS ANTENNA

The mounting location and cable connections for the GPS antenna are very important. The antenna should be mounted no closer than two feet from VHF comm transmitter antennas, six inches from other antennas emitting less than 25 watts, and two feet from higher power antennas. Special care should be taken to ensure that the GPS antenna is not mounted in close proximity to antennas that may emit harmonic interference at the L1 frequency of 1575.42MHz. Refer to the antenna installation manual for installation instructions.

The connectors are included in the installation kit, and are intended for use with RG-142B size coax cable. If using a different diameter coax, alternative connectors may be required. Assembly instructions for the connectors are included in Figure 6 and Figure 7. RG-142B cable can be used as long as the length is less than 20 feet. For longer lengths, use a low loss 50Ω coax.

Suggestion: *Temporarily locate the GPS antenna with coax connected to the SL50/60 and check the GPS performance as described in the GPS Operation and Position test in the Post Installation Checkout on page 24. Once a suitable location has been verified, then permanently mount the antenna.*

Note: *If using a GPS antenna that was already on the aircraft, or if mounting the antenna closer than two feet from a comm antenna, conduct the GPS Operation and Position test in the Post Installation Checkout on page 24. If the SL50/60 passes the test, then moving the antenna is not necessary.*

Once the antenna mounting position has been prepared. route the coax cable from the antenna to the SL50/60. Proper selection of coax cable and assembly of connectors is critical to GPS signal performance. The cable loss from the antenna to the SL50/60 should be limited to a maximum of 4db. Minimize the coax length for optimum performance and **DO NOT** coil excess cable. Leave only enough for service loops. The coaxial connectors and adapters, such as TNC to BNC, add additional loss to the cable and should be considered when computing the maximum 4db loss. A typical loss of 0.2db can be used for each connection. The typical cable loss for 20ft of RG-142B coax with a connector on each end is 4db.

During the post-installation checkout, susceptibility to harmonics of VHF comm transmitters will be evaluated. If problems arise, then better isolation, or distance, may be required

between the GPS and comm antennas, or a notch filter may be installed in series with the antenna coax of the VHF comm transceiver to reduce or eliminate the harmonic interference. A notch filter for this use (part #162-1059) is available from II Morrow.

Note: *The SL60 performance has been verified in typical installations and has not shown to have problems with the built-in comm interfering with the GPS when installed according to the recommended installation guidelines.*

If a VHF comm transmitter causes problems with the GPS on the selected frequencies as listed in the post-installation checkout, the problem may be due to the ELT. This can be verified by disconnecting the ELT antenna coax at the ELT unit. If the ELT is found to cause the problem, then contact the ELT manufacturer or replace the ELT.

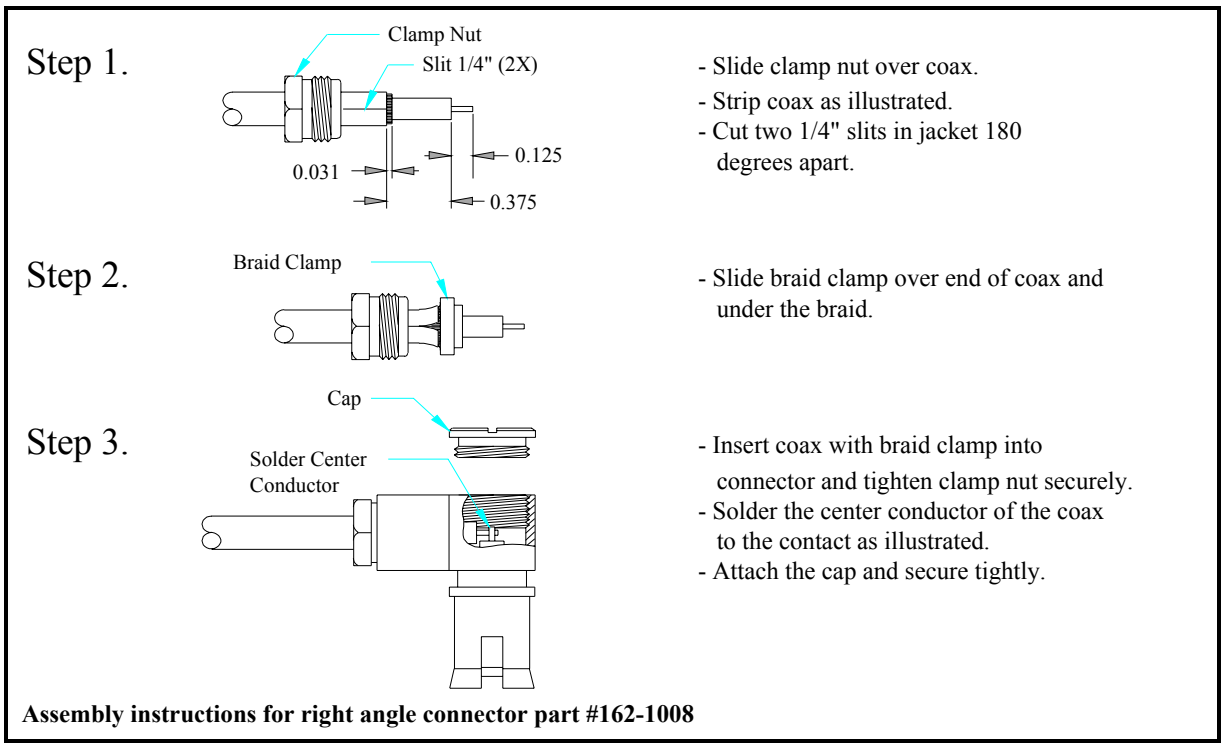

Step 1.
Clamp Nut
Slit 1/4" (2X)
0.125
0.031
0.375
- Slide clamp nut over coax.
- Strip coax as illustrated.
- Cut two 1/4" slits in jacket 180 degrees apart.
Step 2.
Braid Clamp
- Slide braid clamp over end of coax and under the braid.
Step 3.
Cap
Solder Center Conductor
- Insert coax with braid clamp into connector and tighten clamp nut securely.
- Solder the center conductor of the coax to the contact as illustrated.
- Attach the cap and secure tightly.
Assembly instructions for right angle connector part #162-1008

Figure 6 Rear Coax Connector Assembly

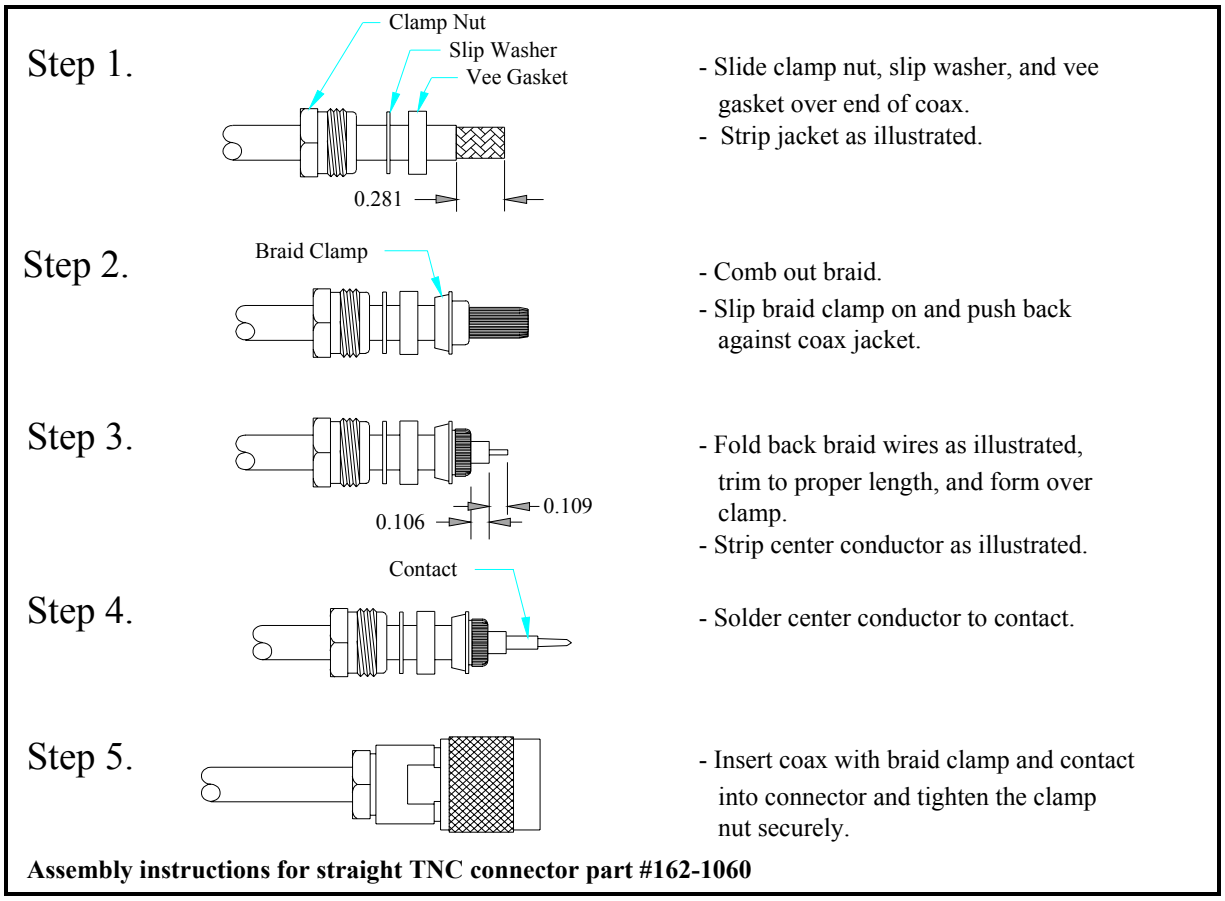

Step 1.
Clamp Nut
Slip Washer
Vee Gasket
0.281
- Slide clamp nut, slip washer, and vee gasket over end of coax.
- Strip jacket as illustrated.
Step 2.
Braid Clamp
- Comb out braid.
- Slip braid clamp on and push back against coax jacket.
Step 3.
0.106
0.109
- Fold back braid wires as illustrated, trim to proper length, and form over clamp.
- Strip center conductor as illustrated.
Step 4.
Contact
- Solder center conductor to contact.
Step 5.
- Insert coax with braid clamp and contact into connector and tighten the clamp nut securely.
Assembly instructions for straight TNC connector part #162-1060

Figure 7 TNC Coax Connector Assembly

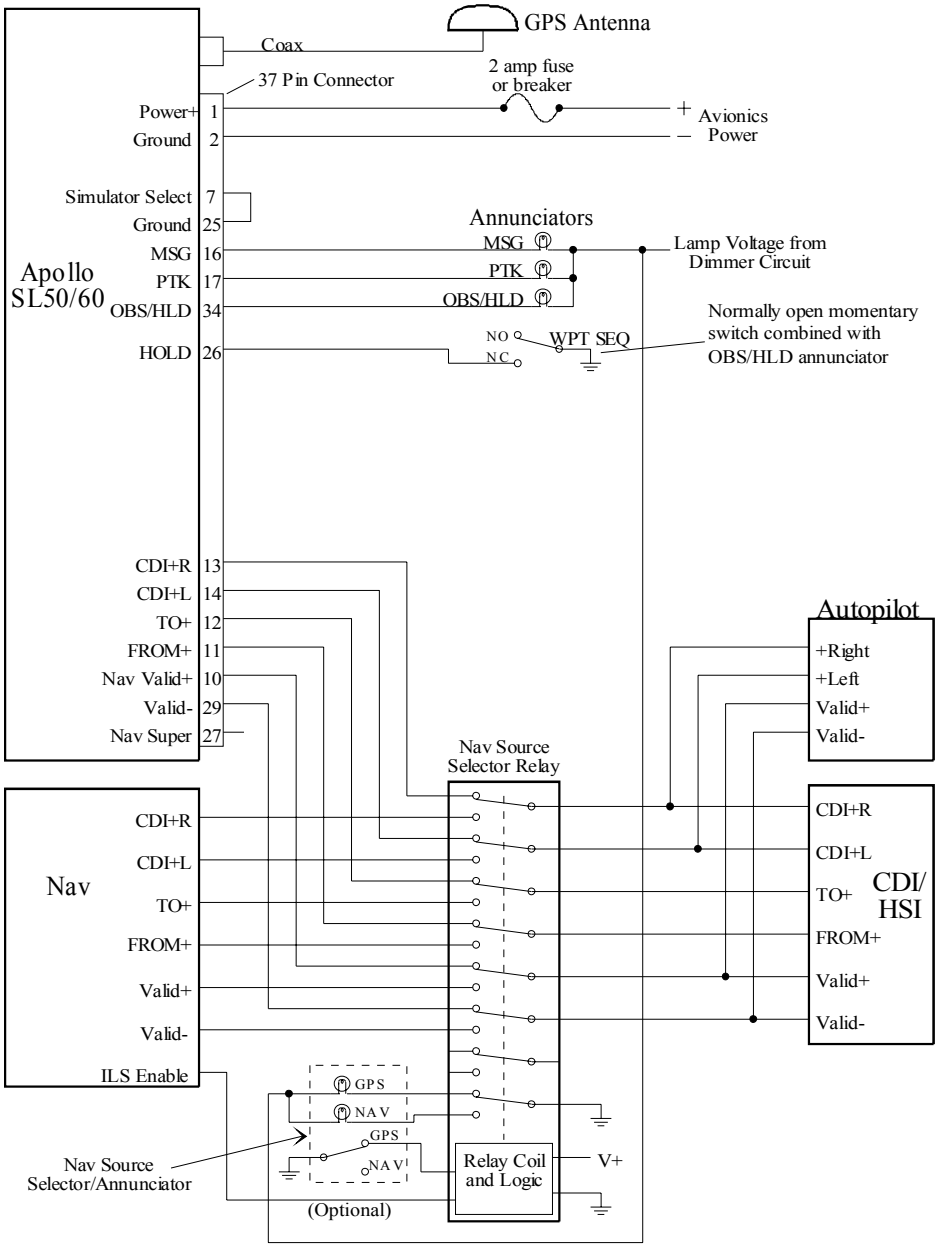
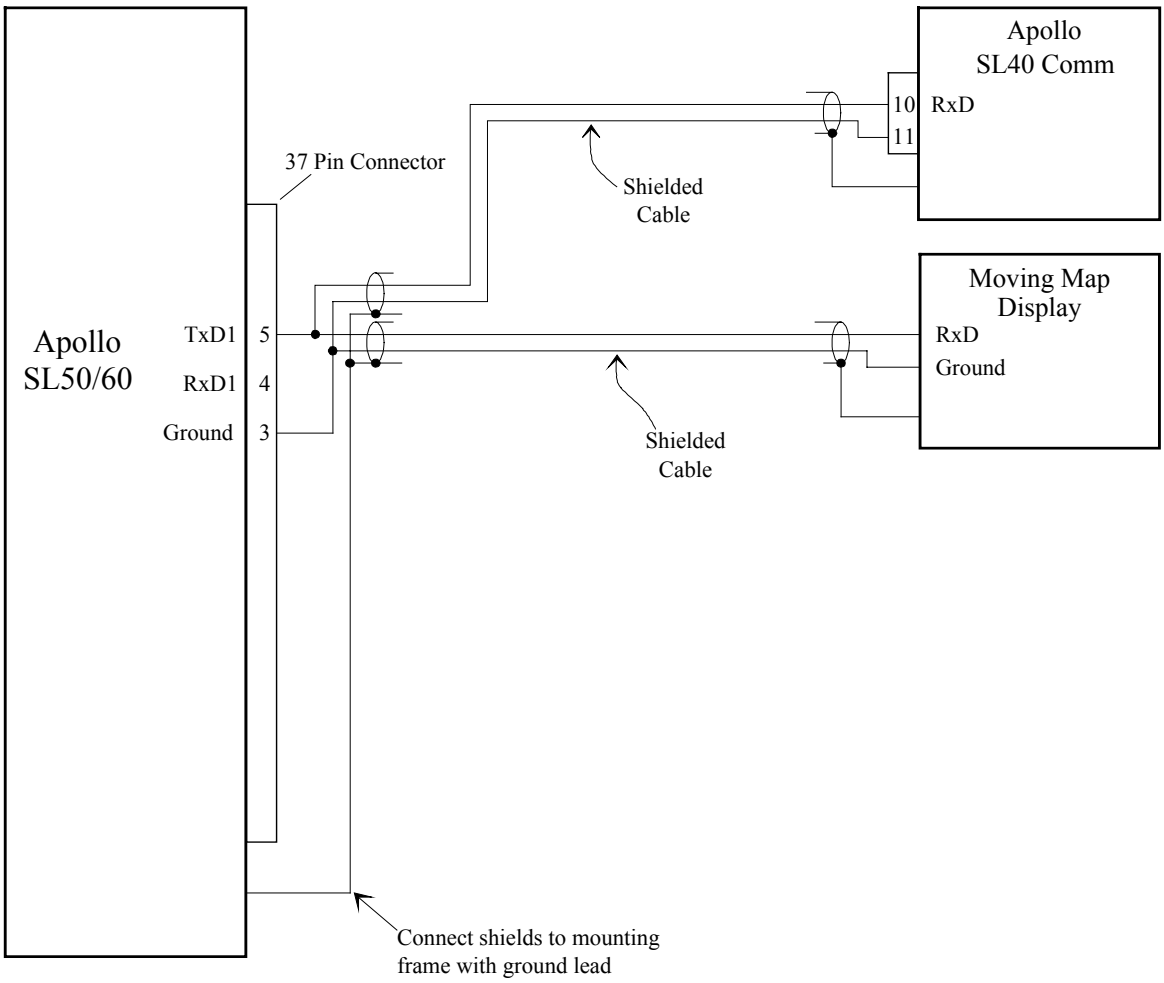
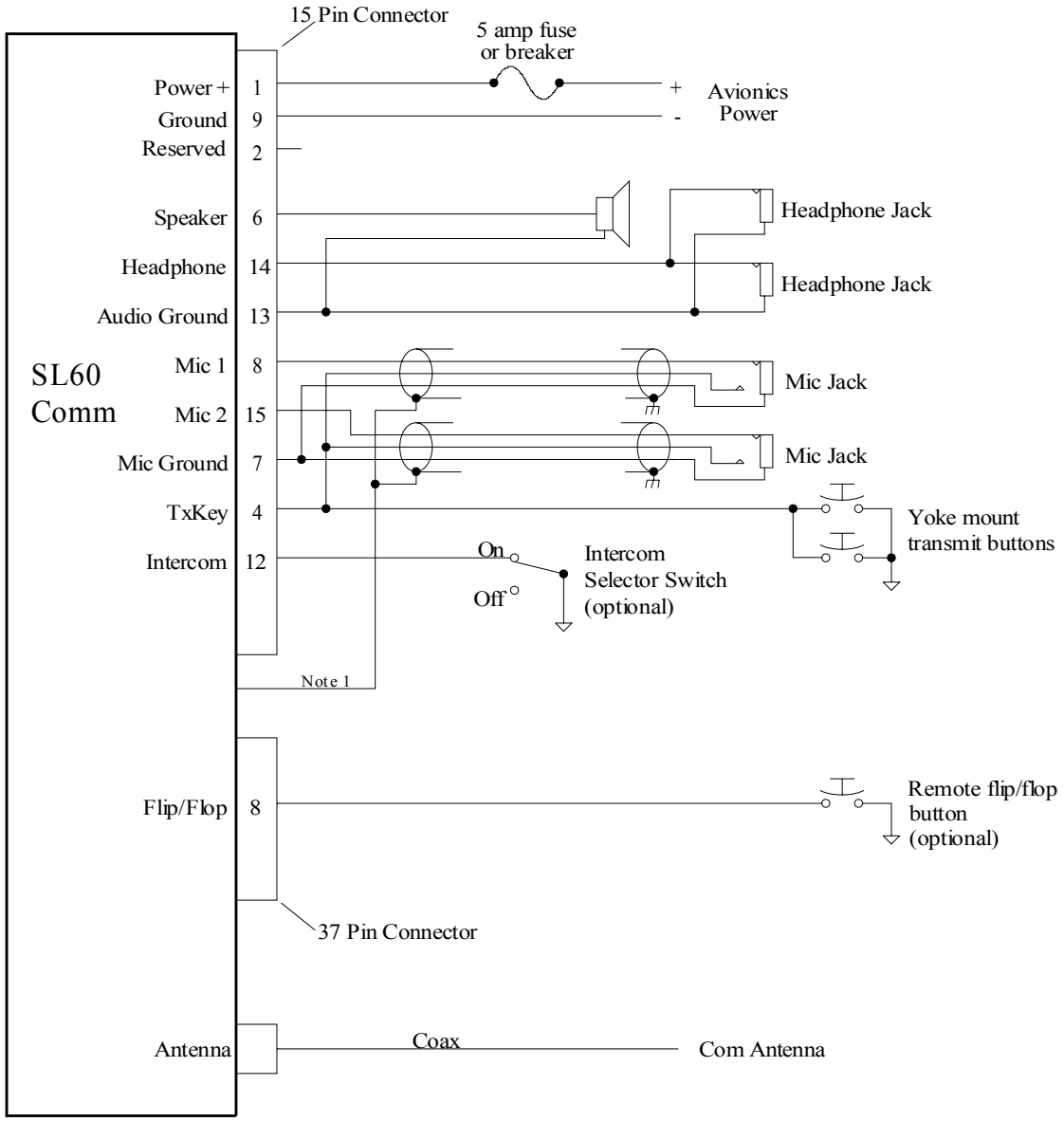


Figure 8 Power and Avionics Connections



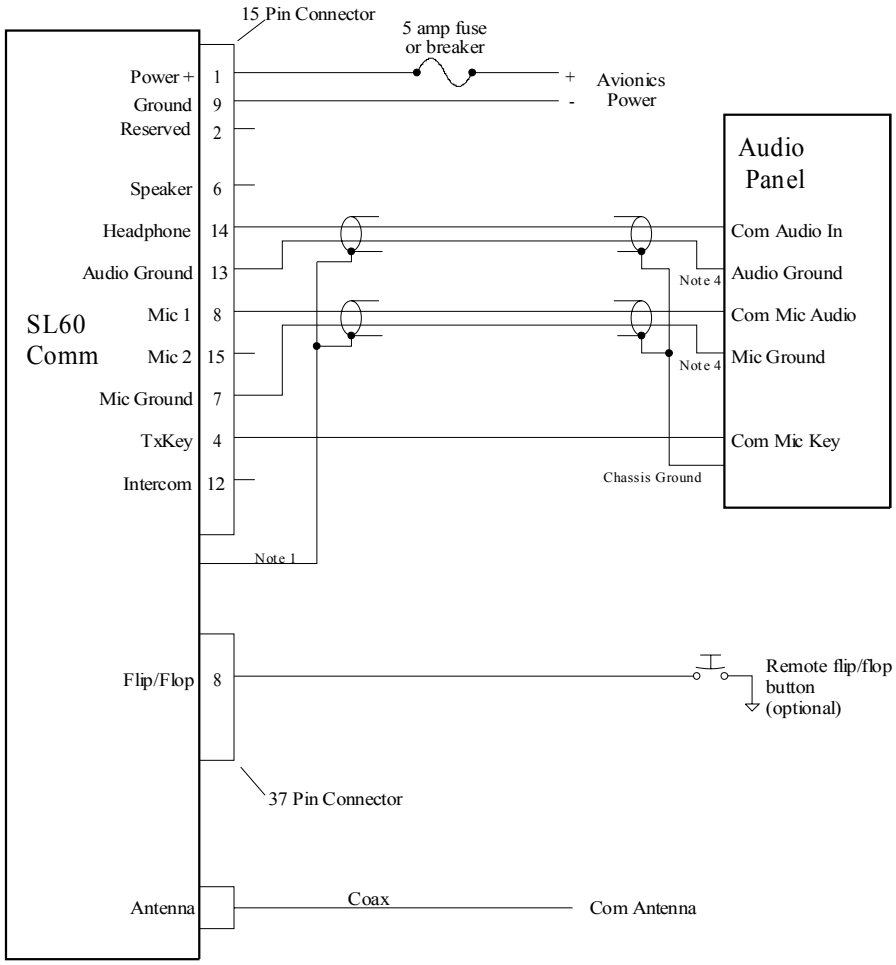
Notes: 1. Use shielded cable for all RS-232 interface connections.
2. Connect cable shields to the rear of the mounting frame with pigtails < 1.25 inches.
3. Connect shields to chassis ground at both ends of each shielded cable.

Figure 9 RS-232 Serial Interface Connections



Notes: 1. Connect cable shields to the rear of the mounting frame, with pigtails < 1.25 inches.
2. Use shielded cable for the microphone connections.
3. Connect shields to ground at both ends of cables.

Figure 10 SL60 Comm Wiring Diagram



Notes: 1. Connect cable shields to the rear of the mounting frame, with pigtails < 1.25 inches.
2. Use shielded cable for the microphone connections.
3. Connect shields to chassis ground at both ends of cables.
4. The audio ground and mic ground connections may use a common point at the audio panel.

Figure 11 SL60 Typical Audio Panel Connections

POST INSTALLATION CHECKOUT

Once the unit is installed, complete the checkout procedure to verify proper operation. Refer to the User's Guide for operating instructions.

The steps that are not applicable to a particular installation may be skipped. A checkout log sheet is included on page 27 to fill out during the checkout procedure. Make a photocopy of the log sheet for ease of use if desired.

The checkout procedure is broken into several groups. The GPS Navigation Checkout, VHF Comm Checkout (SL60), and the Final System Check should be completed with the aircraft moved clear of hangers and other structures.

Mounting / Wiring Check

Verify that all cables are properly secured and shields are connected to the rear of the mounting frame. Check the movement of the aircraft controls to verify that there is no interference.

TEST MODE CHECKOUT AND SETUP

The SL50/60 has a built-in test mode to simplify the checkout. To operate the SL50 in the test mode, hold down the WPT and MSG buttons while switching on the power. For the SL60, hold down the COM and MSG buttons. To return to normal operation, switch the power off, then back on.

Avionics Outputs

Check the avionics output connections by using the test mode as follows. Rotate the LARGE knob to select each test.

1. Using the "CDI TRIANGLE" page, rotate the SMALL knob to check left, mid, and right.
2. Using the "TO/FROM FLAG" page, rotate the SMALL knob to check the Off, To, and From outputs.
3. Using the "LAMP OUTPUTS" page, rotate the SMALL knob to check all the connected annunciators.
4. Using the "VALID FLAG PAGES" page, rotate the SMALL knob to check all the connected valid flag outputs.

Installation Configuration

The SL50/60 must be configured to match the operation supported by the installation. This includes IFR and VFR operation selections.

1. In test mode, rotate the LARGE knob to the "OPTIONS:" page.
2. Press SEL, rotate the SMALL knob to select VFR (IFR? NO) or IFR (IFR? YES) operation, then press ENT when complete.

Note: *Make sure that all installation requirements are complete for the selected operation. Refer to the System Configurations section on page 4 for installation requirements.*

Serial Interface Configuration

The SL50/60 RS-232 serial port can be configured for several different input and output formats. To select the serial port configurations:

1. In test mode, rotate the LARGE knob to the serial port configuration "SERIAL PORT" page.

2. Press SEL (the selection field will start flashing), rotate the SMALL knob to make the desired selection, then press ENT when complete.

The available serial port configurations are included in Appendix E.

Comm Radio Setup

The Test Mode settings may also be used to preset the Microphone (Mic) Gain and the Receiver Squelch levels.

Mic Gain

Set the microphone gain for microphones 1 and 2 for values from 0 to 255.

1. In the Test Mode, rotate the LARGE knob to select "Gain - Mic 1."
2. Press SEL to activate selection. The Mic 1 value will flash.
3. Turn the SMALL knob to change the value.
4. Turn the LARGE knob to the Mic 2 value. Turn the SMALL knob to change the value.
5. Press ENTER to accept and save the settings.

Receiver Squelch

Preset the receiver squelch level for values from 25-100.

1. In the Test Mode, rotate the LARGE knob to select "Receiver Squelch."
2. Press SEL to activate selection. The value will flash.
3. Turn the SMALL knob to select a value.
4. Press ENTER to accept and save the settings.

Other Test Mode Pages

The SL50/60 test mode includes several other pages that are not necessary for the checkout. They are as follows:

"TO TEST DISPLAY"	Can be used to check the SL50/60 front panel displays by pressing ENT.
"TEST CONTROLS"	Can be used to check the SL50/60 front panel controls. Press each button and rotate the SMALL knob to check the controls.
"VDI TRIANGLE"	Factory use only.
"OPERATION STATUS:"	Factory use only. Should be set to "STANDARD."
"SYSTEM INITIALIZATION"	Factory use only. Used to reset all internal memory including user waypoints, flight plans, and configuration data. ***Caution: Using the system initialization function will cause all user data to be lost!***
"A/D CH 1:"	Factory use only. Used to check internal circuits and display voltages.
"EEPROM BYTE 0000:"	Factory use only. Used to display eeprom setup memory.
"COM EEPROM BYTE 0000:"	Factory use only. Used to display Com eeprom setup memory.

GPS NAVIGATION CHECKOUT

Switch on the SL50/60 in the normal mode to complete the this part of the checkout. The SL50/60 will go through a sequence of self tests.

The SL50/60 requires a "seed" position, time, and date for the GPS sensor to know which satellites to look for. Once this is entered, it will be saved and updated automatically. If the SL50/60 is moved a great distance without being turned on, the seed position may have to be re-entered.

Entering the seed position:

1. During the display startup sequence, press SEL when the position page is displayed.
2. Rotate the LARGE knob to move the cursor to different fields, rotate the SMALL knob to input the correct lat/lon, and then press ENT to save the changes.

The seed position can also be input with reference to a waypoint. Refer to the user's manual for instructions.

Entering the time and date:

1. Press the SYS button, rotate the LARGE knob to display the "SYSTEM INFO" page, and press ENT.
2. Press SEL, rotate the LARGE knob to move the cursor to different fields, rotate the SMALL knob to input the correct time, and then press ENT to save the changes.

GPS Operation and Position

This checkout is to be completed with the aircraft moved away from hangars and other structures that may obstruct the view of the satellites.

1. Turn on the SL50/60 and allow the unit to acquire a position. All other avionics should be turned off for this part of the test.
2. Check the position using the lat/lon navigation page. Press the NAV button and rotate the LARGE knob to the lat/lon page. The lat/lon should agree with a known reference position.
3. Check the signal reception using the GPS sensor displays in the System mode. Press the SYS button, rotate the LARGE knob to the "GPS SENSOR:" page, and press ENT. Then rotate the SMALL knob to display the GPS info. Typical signal levels are 50 or better.
4. Turn on other avionics one at a time and check the GPS signal reception to make sure it is not affected.
5. Check for VHF comm transmitter interference. This must be completed on all IFR installations.
   a) Verify that 5 to 8 satellites are in DATA and the NAV flag is out of view.
   b) Tune the comm to 121.150MHz and transmit for 20 seconds.
   c) Verify that the position is not lost.
   d) Repeat for additional frequencies as follows.

121.125MHz	131.225MHz
121.175MHz	131.250MHz
121.200MHz	131.275MHz
121.225MHz	131.300MHz
121.250MHz	131.325MHz

131.200MHz 131.350MHz

e) Repeat for each comm transmitter.

f) If the SL50/60 is susceptible to VHF comm transmitter interference, then better isolation, or distance, may be required between the GPS and VHF antennas. With some comm transmitters, a notch filter may be required in series with the VHF comm antenna coax at the rear of the comm unit.

Note: *Older VHF comm transmitters may emit higher levels of harmonic interference causing greater problems and may be more difficult to deal with.*

Interface Checks

The interfaces to other equipment, such as the SL40 or a moving map display, should be checked. Refer to the SL50/60 user's manual for this part of the checkout. Make sure the other equipment is connected and switched on.

To check the serial data output connections, verify the data from the SL50/60 can be displayed on the other units, such as a moving map display or the SL40.

VHF COMM CHECKOUT (SL60)

Receiver / Transmitter Operation

Tune the unit to a local frequency and verify the receiver output produces a clear and understandable audio output. Verify the transmitter functions properly by contacting another station and getting a report of reliable communications. Check the remote flip/flop.

Antenna Check

The antenna VSWR can be checked using an inline watt meter in the antenna coax using frequencies near both ends of the band. The VSWR should be < 2:1, and is not to exceed 3:1. A VSWR of 2:1 will cause a drop in output power of approximately 12%, and 3:1 causes approximately a 26% drop.

Sidetone Level Adjustment

The sidetone volume was preset at the factory to a typical audio level. The level can be adjusted using one of the built-in system functions. To adjust the sidetone level:

1. Press SYS, rotate the LARGE knob to the "COM RADIO INFO:" page, and press ENT.
2. Rotate the LARGE knob to the "SIDETONE LEVEL:" page.
3. Rotate the SMALL knob to adjust the sidetone level. The sidetone level is displayed in a range of 000 to 255, with 255 the highest level. The sidetone level can be adjusted during transmit.

Comm Flight Test Check

A flight test is recommended as a final installation verification. The performance may be verified by contacting a ground station at a range of at least 50nm while maintaining an appropriate altitude and over all normal flight attitudes. Performance should be checked using low, high, and mid band frequencies.

FINAL SYSTEM CHECK

The SL50/60 GPS navigation functions should be complete at this time. The final check includes checking database, entering a direct to waypoint, and checking the navigation

functions. Start with the unit turned on and operating in the normal mode. Refer to the user's manual for operating instructions.

1. Verify a valid position is displayed.
2. Check the database to ensure it is for the right coverage area and is not expired. To check the database:
   a) Press SYS, rotate the LARGE knob to the "SYSTEM INFO" page, and press ENT.
   b) Rotate the SMALL knob to display the database information. The database name, expiration date, and version will be displayed.
3. Enter a direct to waypoint. Press the DIRECT-TO button, use the LARGE and SMALL knobs to select a nearby waypoint, then press ENT. Or use the nearest search function to select a waypoint.
4. Verify the bearing and distance to the selected waypoint.

If the database is expired, or if a different coverage area is needed, contact the II Morrow factory for an update.

APOLLO SL50 / SL60 POST-INSTALLATION CHECKOUT LOG

Date: ___/___/___
By: _____

CONFIGURATION INFORMATION:

❑ SL50 GPS 430-6040-4__ Mod ____ Serial # _____
❑ SL60 GPS/Comm 430-6040-6__ Mod ____ GPS Antenna: _____
Comm antenna: _____

TEST MODE CHECKOUT AND SETUP:

Avionics Outputs:

❑ [❑ N/A] CDI (left, mid, right)
❑ [❑ N/A] TO/FROM flag (OFF, TO, FROM)
❑ [❑ N/A] External annunciators
❑ [❑ N/A] Valid flags
❑ [❑ N/A] WPT SEQ hold input

Installation Configuration:

IFR?: ❑ Yes ❑ No

Serial Interface Configuration:

_____

GPS NAVIGATION CHECKOUT:

❑ Seed position entered
❑ Time, date entered

GPS Operation:

❑ Position check
❑ Signal reception check
❑ Interference from other avionics checked
❑ VHF comm interference check

Interface Checks:

❑ [❑ N/A] RS-232 outputs checked

VHF COMM CHECKOUT: (SL60 ONLY)

❑ Receiver / Transmitter operation
❑ Antenna check
❑ [❑ N/A] Remote flip/flop input
❑ Sidetone level set / checked
❑ Flight test operation

FINAL SYSTEM CHECK:

❑ Database checked
❑ Direct To waypoint entered
❑ Navigation data checked
❑ Comm checked (SL60 only)

COMMENTS:

NOTES

SECTION 3 - SPECIFICATIONS

This section includes detailed electrical, physical, environmental, and performance specifications for the Apollo SL50 and SL60.

ELECTRICAL

Input voltage	10VDC to 40VDC, reverse polarity protected
Input current (GPS navigation input)	325mA typical, 500mA max at 13.75VDC 170mA typical, 350mA max at 27.5VDC
Input current (comm input)	270mA typical, 2A max at 13.75VDC, receive 130mA typical, 900mA max at 27.5VDC, receive 2.1A typical, 3.2A max at 13.75VDC, transmit 1.0A typical, 1.4A max at 27.5VDC, transmit **Note:** receive max at full receive audio, transmit max at 90% modulation at 1000Hz
Input power (GPS navigation input)	4.7 watts typical
Input power (comm input)	3.7 watts typical, receive 28 watts typical, transmit
Internal fuses	Nav input: 3 amp fast blow, surface mount on board Comm input : 7 amp fast blow, soldered in board
Memory backup	Internal lithium battery with a service life of approximately 4 to 6 years. See Appendix B for battery replacement instructions.

Note: *The SL50/60 will provide a message on the display when the lithium battery is running low and needs replacement.*

PHYSICAL

Height	1.30 inches (3.30 cm)
Width	6.25 inches (15.88 cm)
Depth	11.452 inches (29.09 cm) behind panel, including mounting frame and connectors
Weight (with mounting frame)	SL50: 2.3 lb. (1.04 kg) SL60: 2.8 lb. (1.27 kg)

ENVIRONMENTAL

The Apollo SL50 and SL60 units are designed and tested to meet appropriate categories of RTCA/DO-160C or DO-160D. The Environmental Qualification Form is included in Appendix C.

Operating temperature	-20°C to +55°C

Storage temperature .....-55°C to +85°C

Temperature variation.....2°C per minute

Humidity .....95% at 50°C for 6 hours (2 day cycle)

Maximum altitude.....55,000 feet

Cooling.....Not required

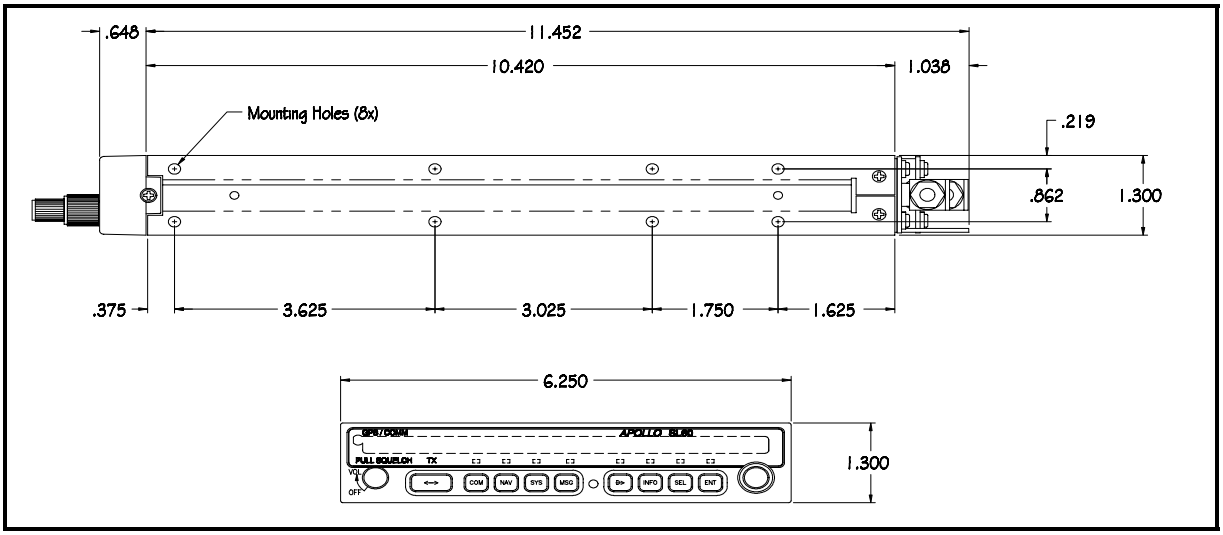


Figure 12 Unit Dimensions

GPS RECEIVER PERFORMANCE

Number of channels 8

Frequency.....1575.42MHz L1, C/A code

Sensitivity (acquisition) .....-135dBm

Sensitivity (drop lock).....-142dBm

Dynamic range .....> 20 dB

Lat/Lon position accuracy.....15 meters RMS typical
25 meters, SEP, without SA
100 meters 2DRMS with SA

Velocity.....1000 knots maximum

Acceleration .....4G maximum

TTFF (time to first fix) .....25 seconds typical with current almanac, position, time, and ephemeris
55 seconds typical with current almanac, position, and time

Reacquisition.....2.5 seconds typical

Position update interval ..... 1 second typical

Datum WGS-84

AVIONICS OUTPUTS

CDI L/R deviation ..... ±150 mv full scale, will drive up to 200 ohm load

TO/OFF/FROM flag..... ±250 mv, TO/FROM indication, will drive up to 200 ohm load

Nav valid flag ..... +300 mv for valid indication, will drive up to 100 ohm load

Nav superflag ..... Vin - 2 volts minimum for valid, source capability of 400 mA

Annunciators ..... Open collector outputs capable of sinking up to 400 mA for turning ON annunciator lamps

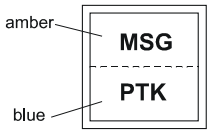
- MSG (message) ON indicates message(s) active
- PTK (parallel track) ON indicates parallel track is enabled
- OBS/HLD (waypoint sequencing hold) ON indicates waypoint sequencing is on hold

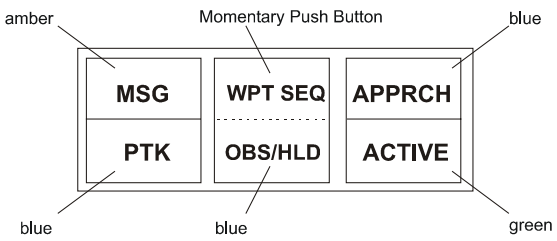
ANNUNCIATOR REQUIREMENTS

The SL50 and SL60 installed for IFR operation require the following annunciators. Each annunciator should include a lamp of the proper voltage for the installation.

Legend	Color	
MSG	amber	
PTK	blue or white	
OBS/HLD	blue or white	optional, to indicate waypoint sequencing hold, can be combined with a momentary "WPT SEQ" hold select push button

The annunciators should be connected to a suitable dimming circuit for night time operation.





Example Annunciators

COMM RECEIVER PERFORMANCE (SL60 ONLY)

Class	D
Frequency range	118.000 to 136.975MHz, 760 channels
Sensitivity	1μV (2μV hard) for 6dB S+N/N with 30% modulation at 1000Hz
Selectivity	< 6dB variation at ± 7KHz, > 60dB at ± 22KHz
Speaker audio output level	12 watts into 4Ω, 8 watts into 8Ω
Headphone audio output level	280mW into 100Ω, 120mW into 500Ω
Distortion	< 5% at rated output at 1000Hz
AGC characteristics	< 3dB variation in audio output from 5μV to 100mV input, 15% to 90% modulation
Squelch control	Automatic squelch with manual override

COMM TRANSMITTER PERFORMANCE (SL60 ONLY)

Class	4
Output power	8 watts minimum carrier at >12VDC input, 6 watts minimum at 10VDC input (transmit is locked out below 9 volts input)
Frequency range	118.000 to 136.975MHz, 760 channels
Frequency tolerance	±15ppm from -20°C to +70°C
Microphone input	Two inputs, standard carbon or dynamic mic with integrated preamp providing minimum 70mv rms into 1000Ω load
Modulation capability	85% with 100mv to 1000mv rms microphone input at 1000Hz
Audio frequency distortion	< 10% at 85% modulation at 350 to 2500Hz
Audio frequency response	< 4db variation with 350 to 2500Hz, 85% modulation
Carrier noise level	> 35db down
Sidetone output	up to 280mW into 100Ω, 120mW into 500Ω
Duty cycle	100%
Stuck mic time-out	35 second time-out, reverts to receive

INTERCOM PERFORMANCE (SL60 ONLY)

Microphone input	Two inputs, standard carbon or dynamic mic with integrated preamp providing minimum 70mv rms into 1000Ω load
Headphone audio output level	280mW into 100Ω, 120mW into 500Ω
AGC characteristics	output varies < 3db with input of 100mv rms to 1000mv rms

CONTROL INPUTS

Simulator select	Must be connected to ground for normal operation, leave open for built-in simulator operation
Hold select	Waypoint sequencing hold input, connect to momentary button to ground for hold input operation, should be combined with the OBS/HLD annunciator
Transmit key (SL60)	Input pulled low to ground to enable the transmitter
Intercom select (SL60)	Input pulled low to ground to enable the intercom function
Flip/Flop	Remote comm flip/flop input, connect to a momentary button to ground for remote flip/flop operation.

ANTENNA REQUIREMENTS

GPS ANTENNA

The SL50 and SL60 are designed to operate properly with the A-33 GPS antenna. The SL50/60 supplies 5 volts for the antenna.

COMM ANTENNA

The Apollo SL60 requires a VHF comm antenna meeting the following specifications.

Standard 50Ω vertically polarized antenna with a VSWR < 2.5:1.

SERIAL INTERFACE

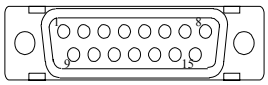
RS-232	Defined in Appendix E - Serial Interface Specifications

REAR CONNECTOR PINOUT

The SL60 includes two rear panel connectors, a 15 pin for the comm interface connections and a 37 pin for the GPS navigation connections. The SL50 uses only the 37 pin connector. The pinout for the connectors is listed in the following tables.

Table 2 Comm Interface Connector Pinout

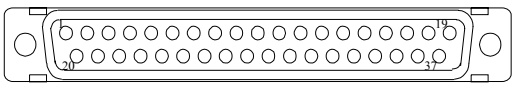
Pin #	I/O	Connection	Function
1	I	Power +	main DC power input
2	I	Reserved	do not connect
3	O	TxD	RS232 serial data output
4	I	TxKey	transmit enable key, pulled low to transmit
5	--	NC	do not connect
6	O	Speaker	speaker terminal output
7	I	Mic ground	microphone input ground connection
8	I	Mic 1	microphone input #1
9	I	Power ground	main power ground input
10	I	RxD	RS232 serial data input
11	O	Serial ground	RS232 signal ground
12	I	Intercom select	intercom function select, pulled low to turn on the intercom function
13	O	Audio ground	speaker and headphone ground connection
14	O	Headphone	headphone terminal output
15	I	Mic 2	microphone input #2



Viewed from rear of unit

Table 3 Navigation Interface Connector Pinout

Pin #	I/O	Connection	Function
1	I	Power +	main DC power input
2	I	Power ground	main power ground input
3	O	Serial ground	RS-232 signal ground
4	I	RxD1	RS-232 channel 1 serial data input
5	O	TxD1	RS-232 channel 1 serial data output
6	I	Ext in 2	reserved
7	I	Simulator select	simulator mode, connect to ground for normal operation
8	I	Flip/Flop	Remote comm frequency flip/flop input
9	O	reserved	do not connect
10	O	Nav + valid	Nav low level valid flag output
11	O	+ FROM	+ From flag output
12	O	+ TO	+ To flag output
13	O	CDI + Right	CDI + Right output
14	O	CDI + Left	CDI + Left output
15	O	reserved	do not connect
16	O	Message	Message annunciator output
17	O	PTK	Parallel track annunciator output
18	--	reserved	do not connect
19	--	reserved	do not connect
20	O	reserved	do not connect
21	I	reserved	do not connect
22	O	reserved	do not connect
23	--	reserved	do not connect
24	O	reserved	do not connect
25	O	Ground	signal ground connection
26	I	Hold select	Hold input
27	O	Nav superflag	Nav high level superflag output
28	O	reserved	do not connect
29	O	Ground	signal ground connection
30	O	reserved	do not connect
31	O	reserved	do not connect
32	O	Ground	signal ground connection
33	O	reserved	do not connect
34	O	Hold	Hold annunciator output
35	O	reserved	do not connect
36	O	Power control	Power control output
37	O	Ground	reserved



Viewed from rear of unit

NOTES

SECTION 4 - LIMITATIONS

INSTALLATION

For minimum equipment and connections required for VFR or IFR installations, refer to the System Configurations on page 4.

Installations of the SL50/60 GPS navigation functions are to be made in accordance with AC 20-138, or other appropriate FAA approved guidelines.

Installations of the SL60 comm functions are to be made in accordance with AC 20-67B or other appropriate FAA approved guidelines.

When the SL50/60 is installed for VFR, a placard stating "GPS Limited to VFR Use Only" or an FAA approved equivalent statement must be placed next to the primary indicator.

The SL60 is qualified for helicopter installation only when the correct mounting hardware and SL60 configurations are used. Mount Tube p/n 310-5181-01 and Connector Mounting Plate p/n 310-5187-01 (or later FAA-approved revisions) are required for helicopter installations and recommended for all installations. SL60 p/n 430-6040-603 (or later FAA-approved revision) or SL60 units upgraded with Mod V should be used in helicopter installations.

OPERATIONAL

An approved Aircraft Flight Manual Supplement is required for IFR installations.

Note: *A sample AFM supplement is available from II Morrow listing operational limitations.*

An aircraft radio station license is required with the SL60 for transmitting.

NOTES

APPENDIX A - TROUBLESHOOTING

This appendix provides information to assist troubleshooting if problems occur after completing the installation. Use Table 4 to assist in troubleshooting.

Table 4 Troubleshooting Guide

Problem	Cause	Solution
The SL50/60 does not power on.	The unit is not getting power.	Check power connections, breakers, and main avionics switch.
The SL50/60 does not compute a position.	Not receiving signals, or incorrect seed position, time, and date.	Make sure a correct position and time/date have been entered. Check the GPS antenna connections. Make sure the aircraft is clear of hangers, buildings, trees, etc.
The GPS signal levels are very low.	Improper antenna installation or coax routing.	Check GPS antenna installation, connections, and cable routing. The GPS antenna must be mounted on the top of the aircraft.
	Antenna shaded from satellites.	Make sure the aircraft is clear of hangers, buildings, trees, etc.
	RF interference at 1575.42MHz from VHF comm.	Move GPS antenna further from the comm antenna. Add a 1575.42MHz notch filter in comm coax. Fix or replace the comm. Disconnect the ELT antenna coax.
GPS signal levels drop when avionics are turned on.	Noise interference from other avionics.	Turn all avionics off, then turn on each piece one at a time to isolate the source of the interference. Route cable and antenna away from sources of interference.
The SL60 does not transmit.	The TxKey input is not being pulled low. A weather channel is selected. No power to the comm. The input voltage is too low.	Check the TxKey (mic key) input, pulled low for transmit. Select a different frequency, the unit will not transmit on a weather channel. Make sure power input is connected to the comm 15 pin connector. Increase input supply voltage to > 9 volts DC.
The sidetone level is too low or too high.	Wrong type of headsets, or level needs adjustment.	See the Sidetone Level Adjustment on page 25.
The intercom doesn't function.	Control input not connected. Active frequency signal present. No voice activation, or have to talk too loud.	The intercom select input must be pulled to ground to turn on the intercom function. Change the active frequency. The active frequency has priority. Change the intercom squelch threshold using the setup function described in the user's manual.

CONTACTING THE FACTORY FOR ASSISTANCE

If the Apollo SL50/60 unit fails to operate despite troubleshooting efforts, contact the II Morrow factory for assistance.

II Morrow Inc.
2345 Turner Rd. SE
Salem, Oregon 97302
USA

Phone (503)581-8101 or 1-800-525-6726

Be prepared with the following information about the installation:

- Installation configuration (accessories, antenna, ...)
- Model number, part number with mod levels, and serial number
- Software versions
- Description of problem
- Efforts made to isolate the problem
- other installed avionics

APPENDIX B - PERIODIC MAINTENANCE

The SL50/60 unit is designed to not require any regular general maintenance except as included in this section.

LITHIUM BATTERY REPLACEMENT

The internal keep alive battery will require replacement after 4 to 6 years. Regular planned replacement is not necessary. The SL50/60 will display a "low battery" message when replacement is required. Once the low battery message is displayed, the battery should be replaced within 1 to 2 months. If the battery is not replaced, the internal ram memory and the system clock information will be lost.

To replace the battery, remove the SL50/60 from the aircraft, remove the top cover, and replace the battery. Make sure to insert the battery in the correct polarity. Replace the top cover, re-install the unit in the aircraft, and verify unit operation.

Battery replacement should be done only by the II Morrow factory or by a trained technician.

Note: The battery is to be replaced only with II Morrow part #148-1702, or a II Morrow approved equivalent.

Caution

The battery may explode if mistreated. Risk of fire, explosion, and burns. Do not recharge, disassemble, heat above 100°C, or incinerate.

Dispose of batteries promptly. Keep away from children.

Be sure the battery is inserted in the right direction.

EQUIPMENT CALIBRATION

The SL50/60 design requires very few adjustments or calibration to be made. In fact, there are **no** internal manual adjustments.

REFERENCE OSCILLATOR

The reference oscillator frequency should be checked approximately every 3 to 5 years to ensure the units transmit frequency is within allowable tolerance.

The oscillator frequency can be checked by connecting the transmitter output through an appropriate load to a calibrated frequency counter. The transmit frequency should be within 15ppm of the selected channel frequency. Contact the II Morrow factory for instructions on adjusting the frequency if required.

CLEANING THE FRONT PANEL

The front bezel, keypad, and display can be cleaned with a soft cotton cloth dampened with clean water. DO NOT use any chemical cleaning agents. Care should be taken to avoid scratching the surface of the display.

NOTES

APPENDIX C - ENVIRONMENTAL QUALIFICATIONS

The Apollo SL50 and SL60 have been tested to the following environmental categories per procedures defined in RTCA/DO-160C or DO-160D.

Environmental Qualification Form			
Model: Part No: TSO No:	SL50 430-6040-4xx TSO-C129	SL60 430-6040-6xx TSO-C129, TSO-C37d, TSO-C38d, TSO-C128	Manufacturer: II Morrow Inc. 2345 Turner Road SE Salem, Oregon 97302

Conditions	DO-160C Section	Description of Conducted Tests
Temperature and Altitude In-flight Loss of Cooling Altitude Overpressure	4.0 4.5.4 4.6.1 4.6.3	Equipment tested to Category C1 with No cooling required Equipment tested to 35,000 feet Equipment tested for overpressure
Temperature Variation	5.0	Equipment tested to Category C, 2°C/min
Humidity	6.0	Equipment tested to Category A, standard humidity environment
Operational Shocks and Crash Safety	7	Equipment tested for both operational and crash safety shocks. (Equipment operated normally after the crash safety shocks.)
Vibration	8.0	Equipment tested without shock mounts to Categories B, M, & N
Explosion Proofness	9.0	Equipment identified as Category X, no test required
Waterproofness	10.0	Equipment identified as Category X, no test required
Fluids Susceptibility	11.0	Equipment identified as Category X, no test required
Sand and Dust	12.0	Equipment identified as Category X, no test required
Fungus Resistance	13.0	Equipment identified as Category X, no test required
Salt Spray	14.0	Equipment identified as Category X, no test required
Magnetic Effect	15.0	Equipment is Class Z
Power Input	16.0	Equipment tested to Categories A & B
Voltage Spike	17.0	Equipment tested to Category A
Audio Frequency Conducted Susceptibility - Power Inputs	18.0	Equipment tested to Categories A & B
Induced Signal Susceptibility	19.0	Equipment tested to Category Z
Radio Frequency Susceptibility (Radiated and Conducted)	20	Equipment tested to Category U
Emission of Radio Frequency Energy	21	Equipment tested to Category Z
Lightning Induced Transient Susceptibility	22.0	Equipment tested to - Category B3 for the GPS navigation connections (37 pin) Category B1 for the GPS antenna connector Categories A3 and B2 for the comm connections
Lightning Direct Effects	23.0	Equipment identified as Category X, no test required
Icing	24.0	Equipment identified as Category X, no test required
Remarks:		

The Apollo SL60 has been tested to the following environmental categories per procedures defined in RTCA/DO-160D to support helicopter installations.

Environmental Qualification Form		
Model: SL60 Part No: 430-6040-603, or later TSO No: TSO-C129, TSO-C37d, TSO-C38d, TSO-C128		Manufacturer: II Morrow Inc. 2345 Turner Road SE Salem, Oregon 97302
Conditions	DO-160D Section	Description of Conducted Tests
Temperature and Altitude In-flight Loss of Cooling Altitude Decompression Overpressure	4.0 4.5.4 4.6.1 4.6.2 4.6.3	Equipment tested to Categories A1 & C1 with No cooling required Equipment tested to 55,000 feet Equipment tested to 55,000 feet Equipment tested for overpressure
Temperature Variation	5.0	Equipment tested to Category C, 2°C/min
Humidity	6.0	Equipment tested to Category A, standard humidity environment
Operational Shocks and Crash Shocks - Impulse-Sustained	7 7.2.1 7.3.1 7.3.2	Equipment tested for both operational and crash safety shocks. Equipment operated normally after 20g shocks Equipment tested at 20g levels Helicopter certification based on DO-160C tests
Vibration	8.0	Equipment tested without shock mounts to Category U Robust Vibration - Helicopter (Curves F and F1) and Category S Standard Vibration (Curves B and M)
Explosion Proofness	9.0	Equipment identified as Category X, no test required
Waterproofness	10.0	Equipment identified as Category X, no test required
Fluids Susceptibility	11.0	Equipment identified as Category X, no test required
Sand and Dust	12.0	Equipment identified as Category X, no test required
Fungus Resistance	13.0	Equipment identified as Category X, no test required
Salt Spray	14.0	Equipment identified as Category X, no test required
Magnetic Effect	15.0	Helicopter certification based on DO-160C tests (see previous page)
Power Input	16.0	
Voltage Spike	17.0	
Audio Frequency Conducted Susceptibility - Power Inputs	18.0	
Induced Signal Susceptibility	19.0	
Radio Frequency Susceptibility (Radiated and Conducted)	20	
Emission of Radio Frequency Energy	21	
Lightning Induced Transient Susceptibility	22.0	
Lightning Direct Effects	23.0	Equipment identified as Category X, no test required
Icing	24.0	Equipment identified as Category X, no test required
Remarks:		

APPENDIX D - ACCESSORIES

This appendix includes information on accessory items available for the Apollo SL50/60. Refer to the information that is provided with those items for complete specifications and installation instructions.

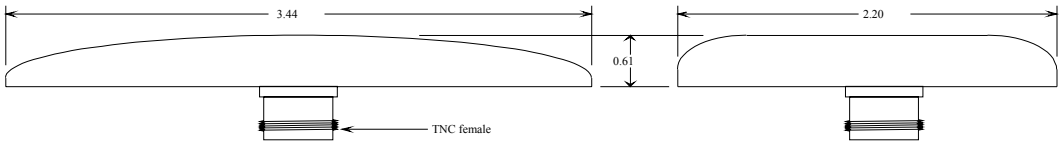
FROM II MORROW

A-33 Antenna
II Morrow Part #:..... 590-1104

Manufacturer: ..... Aero Antenna

Manufacturer #: AT-575-9

The A-33 GPS antenna is a standard accessory item with the SL50/60. The A-33 includes a built-in preamp with 26db gain and has a low profile, low drag radome mounted on a die cast aluminum base. It has a maximum altitude of 55,000 feet and weighs only 3.9 ozs. See the installation manual for the A-33 for complete specifications and installation instructions.



Power / PC Cable
II Morrow Part #:..... 500-4026-00

Manufacturer: ..... II Morrow

The power / PC cable is intended for operation of the SL50/60 unit out of the aircraft. It includes a power cable for connection to a 10 to 40 volts DC supply and a nine pin dsub RS-232 serial connection for connecting to a COM port on a PC.

NOTES

APPENDIX E - SERIAL INTERFACE SPECIFICATIONS

This appendix includes the RS-232 serial port interface specifications.

The RS-232 serial interface configurations supported by the SL50/60 are listed in Table 5. Instructions for configuring the serial port are included in the checkout procedure on page 22.

Table 5 RS-232 Serial Interface Selections

Selection	RX/TX	Comment
NONE/NONE	--	No input or output
NONE/MAP	TX	Moving map data output
NONE/MAPCOM	TX	Moving map data output with SL40 comm data
PC / SETUP	RX/TX	Used for factory test

MOVING MAP OUTPUT

The format of the moving map data output is as follows. Definitions of the output data is included in Table 6 and Table 7. A sample output message is included in Figure 13.

Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: ..... none
Output rate: ..... approx 2 seconds
Message length: ..... variable, approx 83 to 484 characters

The serial output messages are in the following format.

<STX><id><data><it><id><data><it>...<id><data><it><ETX>

<STX> ..... ASCII “start of text” character (1 byte, 02h)
<id> ..... item designator (1 byte, from following table)
<data> ..... item data (format listed in following table)
<it> ..... item terminator (1byte, 0Dh)
<ETX> ..... ASCII “end of text” character (1 byte, 03h)

Table 6 Moving Map ASCII Navigation Data			
ID	**Data Format**	**Length**	**Description**
A	sddmmhh	9	Present latitude s =sign: N for north, S for south dd = degrees mm = minutes hh = hundredths of minutes
B	sdddmmhh	10	Present longitude s = sign: E for east, W for west ddd = degrees mm = minutes hh = hundredths of minutes
C	ddd	3	Track (magnetic): ddd = degrees
D	ddd	3	Ground speed: ddd = knots
E	ddddd	5	Distance to active waypoint: ddddd = nm x 10
G	sdddd	5	Cross track error: s = sign: R for right, L for left of course dddd = distance off course, hundredths of nm
I	dddd	4	Desired track (magnetic): dddd = degrees x 10
K	ddd[dd]	3 to 5	Active waypoint identifier: ddd[dd] = ASCII waypoint identifier
L	dddd	4	Bearing to active waypoint (magnetic): dddd = degrees x 10
Q	sddd	4	Magnetic variation: s = sign: E for east, W for west ddd = degrees x 10
T	---A-----	9	Warnings: The 4th character will be an “A” when the navigation data is flagged, otherwise, all characters will be dashed. All other navigation data will be dashed when it is flagged.

Table 7 Moving Map Binary Route Data		
Byte	**Data Format**	**Description**
1	w	Item designator
2-3	dd	Current waypoint number in ASCII (01h to 20h)
4	xiannnnn	Sequence number x = undefined i = 1 if last waypoint a = 1 if active waypoint nnnnn = unsigned binary waypoint number
5-9	ddddd	ASCII waypoint identifier
10 11 12	sddddddd xxmmmmmm xhhhhhhh	Waypoint latitude - packed, unsigned binary s = sign: 0 for north, 1 for south ddddddd = degrees mmmmmm = minutes hhhhhhh = hundredths of minutes x = undefined
13 14 15 16	sxxxxxxx sddddddd xxmmmmmm xhhhhhhh	Waypoint longitude s = sign: 0 for east, 1 for west ddddddd = degrees mmmmmm = minutes hhhhhhh = hundredths of minutes x = undefined
17 18	nnnnnnnn nnnnnnnn	Magnetic variation at waypoint LS byte (msbit...lsbit) MS byte (msbit...lsbit) Two’s complement binary in sixteenths of degrees, easterly variation is positive.
19	<CR>	ASCII carriage return (0Dh)

Example Moving Map Data Output

AN 34 1570	34°15.70' latitude
BW 118 4390	118°43.90' longitude
C306	306° track angle
D210	210 knots
E02682	268.2nm to waypoint
GR0006	0.6nm right of course
I3059	305.9° desired track
KSFO	SFO waypoint ident
L3058	305.8° bearing to waypoint
QE140	14.0° east magnetic variation
T---------	No alarms, data not flagged
<binary data>	From Table 7

Figure 13 Moving Map Data Output

COMM DATA OUTPUT

The format of the comm data output is as follows. This data output is compatible with the SL40 for sending frequency data to the comm.

Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: .....none
Output rate: .....approx 2 seconds
Message length: .....variable, approx 83 to 484 characters

The comm data is output using the following format.

$PMRRC<msg_id><msg_data><chksum><cr>

The checksum is computed by an 8 bit addition of the msg_id and msg_data characters, ignoring carry if any. The resulting 8 bit checksum is converted to two ascii characters by taking the upper and lower nibbles, adding 30h to each, and placing the most significant character first in the data message.

Airport Ident Output
This message is used to output the selected airport ident.

Message Format
$PMRRC04tiiii<chksum><cr>

04 .....message id
t .....list type, outputs a 1
iiii.....ident, four character ascii

Example Message
$PMRRC041SLE<space>99<cr>

Output ident of "SLE" for the following frequency information.

Frequency Data Output
This message is used to output the airport frequency information for the previously output ident.

Message Format
$PMRRC05tfmk<chksum><cr>

05..... message id
t..... list type, input 1
f ..... frequency type:

0 = TWR, tower frequency	8 = CTF, common traffic advisory frequency
1 = GND, ground frequency	9 = DEP, departure
2 = ATS, for ATIS	: (3Ah) = FSS, flight service station
3 = ATF, air traffic frequency	
4 = APP, for approach	< (3Ch) = UNI, for unicom
5 = ARR, for arrival	= (3Dh) = MF, mandatory frequency
6 = AWS, automatic weather station	> (3Eh) = CNT, Center
7 = CLR, clearance/delivery	? (3Fh) = undefined, for other frequency types

mk..... frequency:
m = desired frequency in MHz in hexadecimal, where m = desired frequency - 30h , with the desired frequency in the range of 118 to 136 MHz, or 162 MHz.
k = desired frequency in kHz where k = (desired frequency / 25 kHz) + 30h, with the desired frequency in the range of 000 to 975 kHz in 25 kHz steps, or 0 to 39.

Example Message
$PMRRC0511IT64<cr>

The above example message outputs a ground frequency type, 121.900 MHz.

Remote VOR List
The following two commands work together in allowing remotely connected devices to provide a list of VOR frequencies to the SL30. The remote device will send a sequence of Remote VOR Input commands (message identifier 20). When all of the VOR Input commands have been sent, the remote device should send a Remote VOR List Trailer command (message identifier 21) to terminate the list. The transmitted list will not be considered complete by the SL30 until it receives the trailer message. The unit will maintain a single remote VOR list, so each list received will replace any previous list. There may be up to twenty entries in the remote VOR list. Any entries past twenty will be ignored.

Remote VOR Input
This input is used to input VOR frequency data used for the remote recall function.

The data consists of five characters for the VOR station identifier followed by two characters defining the VOR frequency.

Message format:
"V" ..... Message Class. This is a VHF NAV message.
"20" ..... Message Identifier.

vvvv .....VOR station identifier. Note that if the station identifier is less than four characters, then the trailing characters will be filled with spaces. Station Identifiers are restricted to using ASCII characters 0-9 and A-Z.

mk .....Frequency: m = MHz, where m = desired MHz frequency – 30h, with the desired frequency ranging from 108 to 117, or 3Ch to 45h; k = kHz, where k = (desired kHz offset / 25 kHz) + 30h, with desired frequency range of 000 to 975 kHz in 50 kHz steps, or the even numbers from 30h to 56h. Note that the field will be checked to ensure that it is in range and a valid VOR frequency. Frequencies used for localizers, which are in the range of 108.10 to 111.95 MHz, will not be accepted in this message type.

Example message:

$PMRRV20UBG<Sp>E@<chksm><CR><LF>

VOR station identifier is "UBG ", VOR frequency is 117.400 MHz.

Remote VOR List Trailer

This input command marks the end of a VOR list sent by a remote device.

Message format:

"V" Message Class. This is a VHF NAV message.
"21" Message Identifier

Example message:

$PMRRV21<chksm><CR><LF>

Indicates the start of a remote VOR list.

REMOTE LOCALIZER LIST

The following two commands work together in allowing remotely connected devices to provide a list of localizer frequencies associated with an airport to the SL30. The remote device should first send the Remote Localizer List Header command (message identifier 22), followed by a sequence of Remote Localizer Input commands (message identifier 23). The SL30 maintains a single remote localizer list, so each new list received will replace any previous list. Subsequent receptions of localizer lists for the same airport are ignored. There may be up to twenty entries in the remote Localizer list. Any entries past twenty will be ignored.

Remote Localizer List Header

This input command marks the beginning of a Localizer list sent by a remote device. It specifies the five character airport identifier associated with the localizer frequencies in the list.

Message format:

"V".....Message Class. This is a VHF NAV message.

"22" ..... Message Identifier.
aaaa..... Airport identifier. Note that if the airport identifier is less than four characters, then the trailing characters will be filled with spaces. Airport Identifiers are restricted to using ASCII characters 0-9 and A-Z.

Example message:
$PMRRV22SLE<Sp><chksum><CR><LF>

Indicates the start of a remote localizer list associated with the airport "SLE ".

Remote Localizer Input
This input is used to input Localizer frequency data used for the remote recall function.

The data consists of three characters to identify the runway associated with the localizer, followed by two characters defining the frequency.

Message format:
"V" ..... Message Class. This is a VHF NAV message.
"23" ..... Message Identifier.
iiii ..... Station or Runway identifier. This field will provide an identifier for the localizer which can be either the actual station identifier or a string indicating the runway associated with the localizer. The station identifier can be up to four characters long. A runway identifier will typically be two numbers that indicate the runway direction followed by the character "R", "C", or "L" to differentiate between parallel runways (right, center, and left). Note that if either type of identifier is less then four characters, then the trailing characters will be filled in with spaces. Identifiers are restricted to using ASCII characters 0-9 and A-Z.
mk..... Frequency: m = MHz, where m = MHz frequency – 30h, with the desired frequency ranging from 108 to 111 MHz, or 3Ch to 3Fh; k = (desired kHz offset / 25 kHz) + 30h, where the desired frequency ranges from 000 to 950 kHz, or the even numbers from 30h to 56h. Note that the field will be checked to ensure that it is in range and a valid localizer frequency. Frequencies used for VORs, which can also be found in the range of 108.10 to 111.95 MHz, will not be accepted in this message type.

Example message:
$PMRRV2331<Sp><Sp>><<chksm><CR><LF>

Identifier is "31 ", indicating a runway, and the localizer frequency is 110.300 MHz.

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